

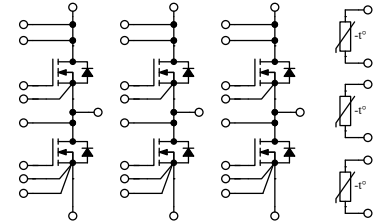
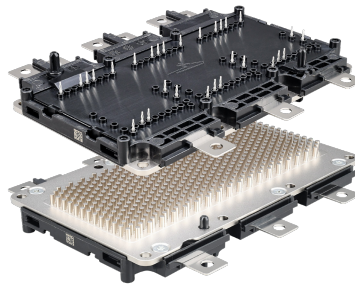
# ECB4R3M12YM3

1200 V, 4.3 mΩ, Silicon Carbide, Six-Pack Module

<b>V<sub>DS</sub></b>	<b>1200 V</b>
<b>R<sub>DS(on)</sub></b>	<b>4.3 mΩ</b>

## Technical Features

- Fully SiC MOSFET-based for Ultra-Low Loss
- Comparative Tracking Index (CTI) > 600 V for Material Group I
- Extremely Low Power Loop Inductance (6.6 nH)
- High Performance Si<sub>3</sub>N<sub>4</sub> Insulator
- Ultra-Reliable Interconnect Technologies
- AQG-324 Qualification



## Typical Applications

- Automotive Traction Inverters
- Commercial, Construction, and Agricultural Vehicles
- Hybrid Electric Vehicles
- E-Mobility and Motor Drives
- Auxiliary Power Supplies
- Renewable Energy

## System Benefits

- Direct-Cooled Pin Fin Baseplate
- Industry-Standard Footprint
- Press-fit Connection for Ease of Assembly
- Integrated NTC Temperature Sensors

## Maximum Parameters (Verified by Design)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Note
Drain-Source Voltage	V <sub>DS</sub>			1200	V		
Gate-Source Voltage, Maximum Value	V <sub>GS max</sub>	-10		+23		Transient	Fig. 32
Gate-Source Voltage, Recommended	V <sub>GS op</sub>		-4/+15			Static	Note 1
DC Continuous Drain Current (V <sub>GS</sub> = 15 V, T <sub>VJ</sub> ≤ 175 °C)	I <sub>D</sub>		385		A	T <sub>F</sub> = 25 °C, Flow Rate = 10 LPM	Notes 2, 3 Fig. 20
			330			T <sub>F</sub> = 65 °C, Flow Rate = 10 LPM	
Pulsed Drain Current	I <sub>DM</sub>		660			t <sub>pmax</sub> limited by T <sub>VJmax</sub> V <sub>GS</sub> = 15 V, T <sub>C</sub> = 25 °C	
Power Dissipation	P <sub>D</sub>		1100		W	T <sub>F</sub> = 25 °C, T <sub>VJ</sub> ≤ 175 °C	Fig. 21 Note 4
Virtual Junction Temperature	T <sub>VJ op</sub>	-40		175	°C	Operation	

Note (1): Recommended turn-on gate voltage is 15 V with ±5% regulation tolerance

Note (2): Current limit calculated by  $I_{D(max)} = \sqrt{(P_D / R_{DS(typ)}(T_{VJ(max)}, I_{D(max)}))}$

Note (3): Verified by design

Note (4):  $P_D = (T_{VJ} - T_C) / R_{TH(JC,typ)}$


**MOSFET Characteristics (Per Position) ( $T_{vj} = 25^\circ\text{C}$  unless otherwise specified)**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Note
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	1200			V	$V_{GS} = 0\text{ V}, T_{vj} = -40^\circ\text{C}$	
Gate Threshold Voltage	$V_{GS(th)}$	1.8	2.5	3.6		$V_{DS} = V_{GS}, I_D = 84\text{ mA}$	
			2.0			$V_{DS} = V_{GS}, I_D = 84\text{ mA}, T_{vj} = 175^\circ\text{C}$	
Zero Gate Voltage Drain Current	$I_{DSS}$		4	150	$\mu\text{A}$	$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}$	
Gate-Source Leakage Current	$I_{GSS}$		40	1000	nA	$V_{GS} = 15\text{ V}, V_{DS} = 0\text{ V}$	
Drain-Source On-State Resistance (Devices Only)	$R_{DS(on)}$		4.3	5.5	m $\Omega$	$V_{GS} = 15\text{ V}, I_D = 350\text{ A}$	Fig. 2 Fig. 3
			7.5			$V_{GS} = 15\text{ V}, I_D = 350\text{ A}, T_{vj} = 175^\circ\text{C}$	
Transconductance	$g_{fs}$		289		S	$V_{DS} = 20\text{ V}, I_{DS} = 350\text{ A}$	Fig. 4
			265			$V_{DS} = 20\text{ V}, I_{DS} = 350\text{ A}, T_{vj} = 175^\circ\text{C}$	
Turn-On Switching Energy, $T_{vj} = 25^\circ\text{C}$ $T_{vj} = 125^\circ\text{C}$ $T_{vj} = 175^\circ\text{C}$	$E_{On}$		13.4 12.5 12.4		mJ	$V_{DD} = 600\text{ V}$ $I_D = 350\text{ A}$ $V_{GS} = -4\text{ V}/15\text{ V}$ $R_{G(OFF)} = 3.0\text{ }\Omega, R_{G(ON)} = 10.0\text{ }\Omega$ $L_g = 16.1\text{ nH}$	Fig. 11 Fig. 13
Turn-Off Switching Energy, $T_{vj} = 25^\circ\text{C}$ $T_{vj} = 125^\circ\text{C}$ $T_{vj} = 175^\circ\text{C}$	$E_{Off}$		7.6 7.5 7.6				
Internal Gate Resistance	$R_{G(int)}$		0.9		$\Omega$	$f = 100\text{ kHz}$	
Input Capacitance	$C_{iss}$		25.6		nF	$V_{GS} = 0\text{ V}, V_{DS} = 800\text{ V}$ $V_{AC} = 25\text{ mV}, f = 100\text{ kHz}$	Fig. 9
Output Capacitance	$C_{oss}$		0.9				
Reverse Transfer Capacitance	$C_{rss}$		59.2		pF		
Gate to Source Charge	$Q_{GS}$		288		nC	$I_D = 350\text{ A}, V_{DS} = 800\text{ V}$ $V_{GS} = -4\text{ V}/15\text{ V}$ Per IEC60747-8-4 pg 21	
Gate to Drain Charge	$Q_{GD}$		236				
Total Gate Charge	$Q_G$		848				
FET Thermal Resistance, Junction to Fluid	$R_{th\text{ JF}}$		0.136		$^\circ\text{C/W}$	Flow Rate = 10 LPM, $T_F = 65^\circ\text{C}$	Fig. 17

**Diode Characteristics (Per Position) ( $T_{vj} = 25^\circ\text{C}$  unless otherwise specified)**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Notes
Body Diode Forward Voltage	$V_{SD}$		6.0		V	$V_{GS} = -4\text{ V}, I_{SD} = 350\text{ A}$	Fig. 7
			5.2			$V_{GS} = -4\text{ V}, I_{SD} = 350\text{ A}, T_{vj} = 175^\circ\text{C}$	
DC Source-Drain Current (Body Diode) ( $V_{GS} = -4\text{ V}, T_{vj} \leq 175^\circ\text{C}$ )	$I_{BD}$		234		A	$T_F = 25^\circ\text{C}, \text{Flow Rate} = 10\text{ LPM}$	
			180			$T_F = 65^\circ\text{C}, \text{Flow Rate} = 10\text{ LPM}$	
Reverse Recovery Time	$t_{RR}$		50.4		ns	$V_{GS} = -4\text{ V}, I_{SD} = 350\text{ A}, V_R = 600\text{ V}$ $di/dt = 4.1\text{ A/ns}, T_{vj} = 175^\circ\text{C}$	
Reverse Recovery Charge	$Q_{RR}$		3.2		$\mu\text{C}$		
Peak Reverse Recovery Current	$I_{RRM}$		104.4		A		
Reverse Recovery Energy, $T_{vj} = 25^\circ\text{C}$ $T_{vj} = 125^\circ\text{C}$ $T_{vj} = 175^\circ\text{C}$	$E_{RR}$		0.1 0.2 0.4		mJ	$V_{DD} = 600\text{ V}, I_D = 350\text{ A},$ $R_{G(ON)} = 10.0\text{ }\Omega, V_{GS} = -4\text{ V}/15\text{ V}$ $L_g = 16.1\text{ nH}$	Fig. 14



## Module Physical Characteristics

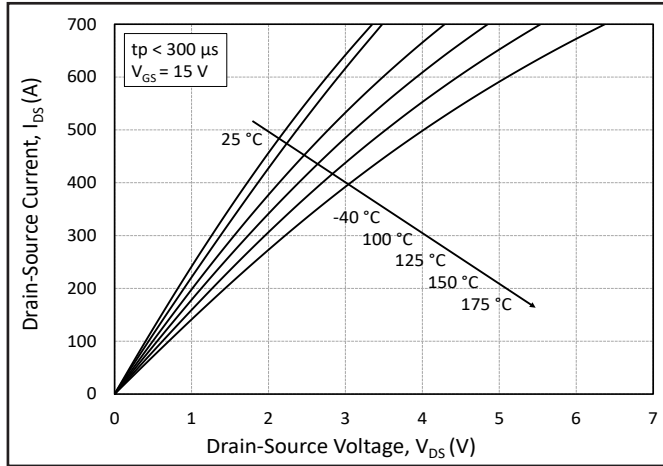
Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Package Resistance, (High-Side)			0.30		mΩ	T <sub>F</sub> = 25°C, Note 5
Package Resistance, (Low-Side)			0.22			T <sub>F</sub> = 25°C, Note 5
Comparative Tracking Index	CTI	600				
Baseplate Material			Cu+Ni			
Internal Isolator Material			Si <sub>3</sub> Ni <sub>4</sub>			Basic insulation (class 1, IEC 61140)
Stray Inductance	L <sub>Stray</sub>		6.6		nH	Between DC- and DC+
Case Temperature	T <sub>C</sub>	-40		125	°C	
Mounting Torque	M <sub>S</sub>	1.8		2.2	N-m	Baseplate, M4 bolts
		3.6		4.4		Power Terminals, M5 bolts
Weight	W		805		g	
Case Isolation Voltage	V <sub>isol</sub>		4.2		kV	f = 0 Hz, t = 1 sec
Maximum Pressure in Cooling Circuit	p			2.5	bar	
Clearance Distance			4.3		mm	Terminal to Terminal
			4.5			Terminal to Heatsink
Creepage Distance			9.2			Terminal to Terminal
			9.8			Terminal to Heatsink

## NTC Characteristics (T<sub>NTC</sub> = 25 °C unless otherwise specified)

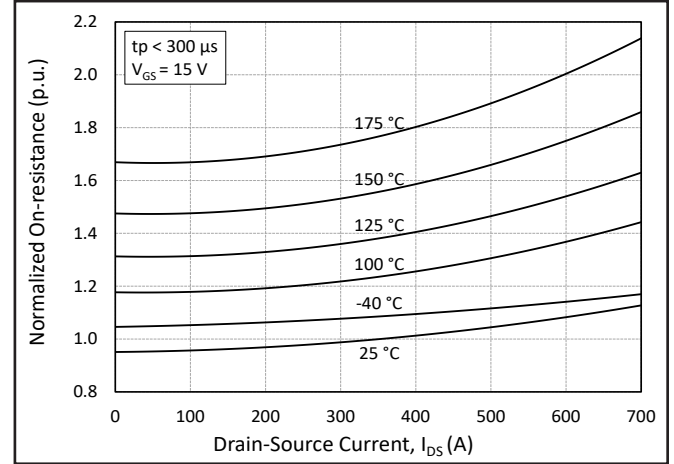
Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Resistance at 25°C	R <sub>25</sub>	4750	5000	5250	Ω	
Tolerance of R <sub>100</sub>	ΔR/R	-9.22		9.89	%	T <sub>NTC</sub> = 100 °C, R <sub>100</sub> = 493.3 Ω
Beta Value for 25°C to 50°C	B <sub>25/50</sub>	3307	3375	3343	K	
Beta Value for 25°C to 80°C	B <sub>25/80</sub>	3346	3414	3482	K	
Beta Value for 25°C to 100°C	B <sub>25/100</sub>	3368	3436	3503	K	
Maximum Power Dissipation	P <sub>25</sub>		1.4		mW	

Note (5): Total Effective Resistance (Per Switch Position) = MOSFET R<sub>DS(on)</sub> + Switch Position Package Resistance

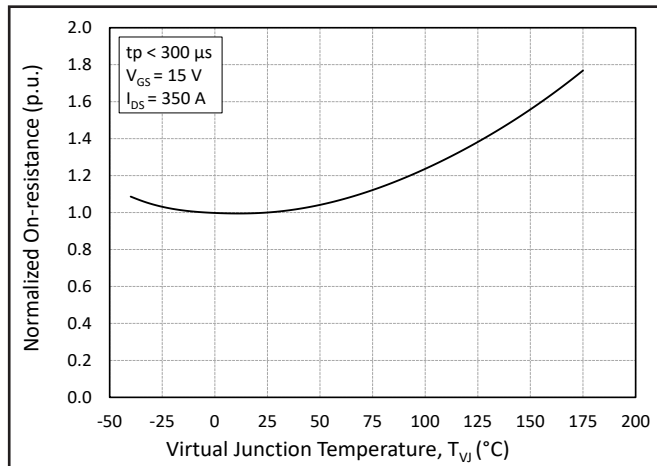
## Typical Performance



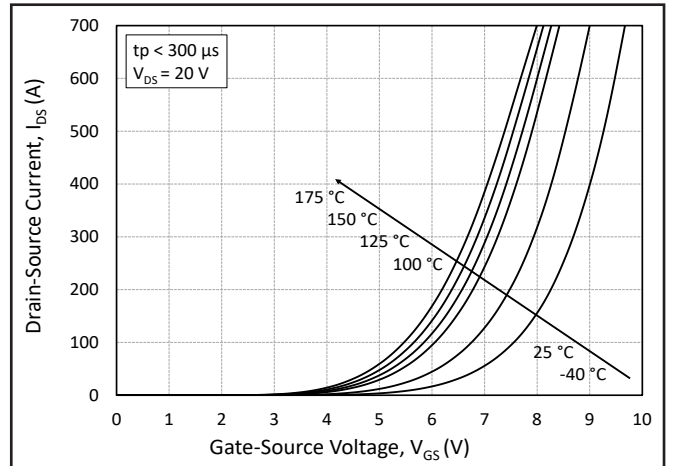
**Figure 1.** Output Characteristics for Various Junction Temperatures



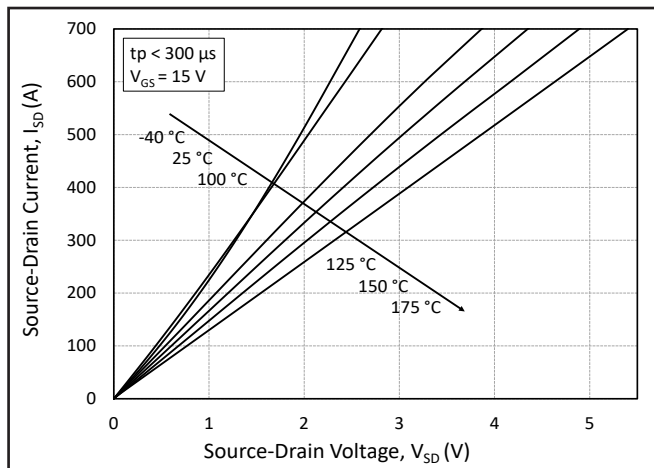
**Figure 2.** Normalized On-State Resistance vs. Drain Current for Various Junction Temperatures



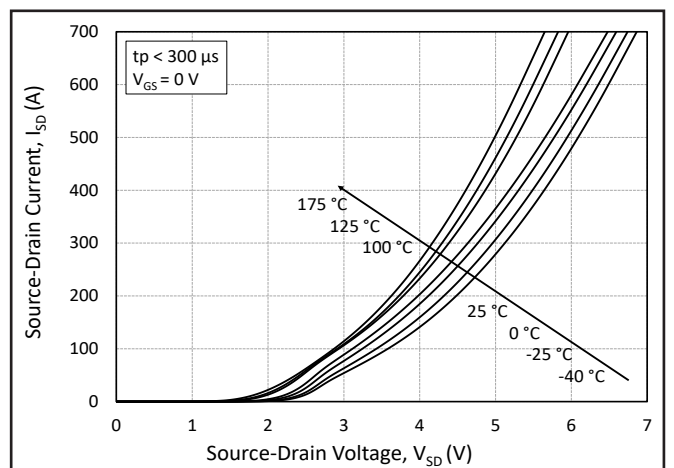
**Figure 3.** Normalized On-State Resistance vs. Junction Temperature



**Figure 4.** Transfer Characteristic for Various Junction Temperatures

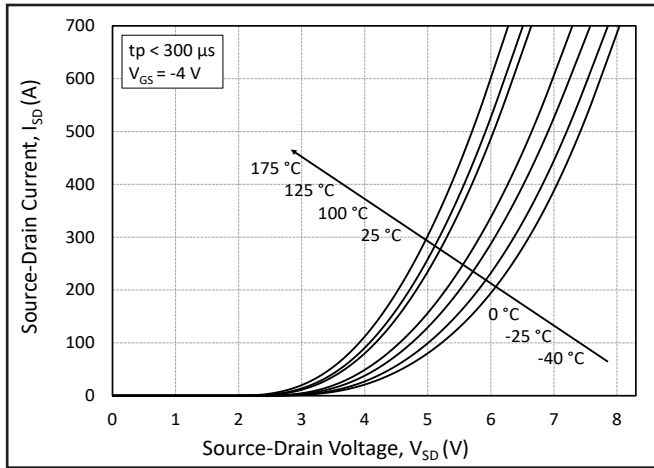


**Figure 5.** 3<sup>rd</sup> Quadrant Characteristic vs. Junction Temperatures at  $V_{GS} = 15$  V

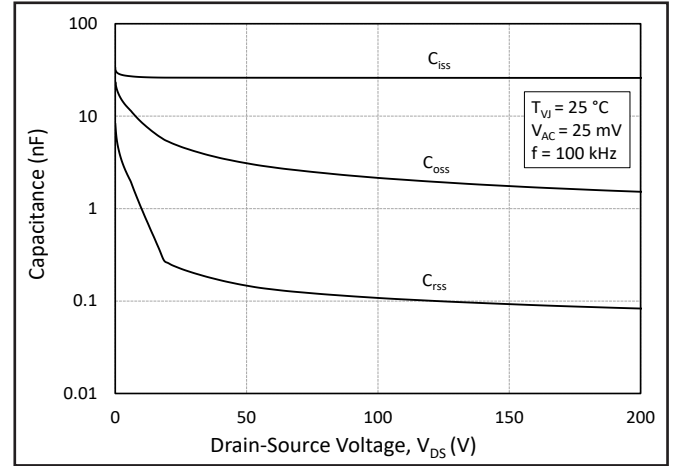


**Figure 6.** 3<sup>rd</sup> Quadrant Characteristic vs. Junction Temperatures at  $V_{GS} = 0$  V (Body Diode)

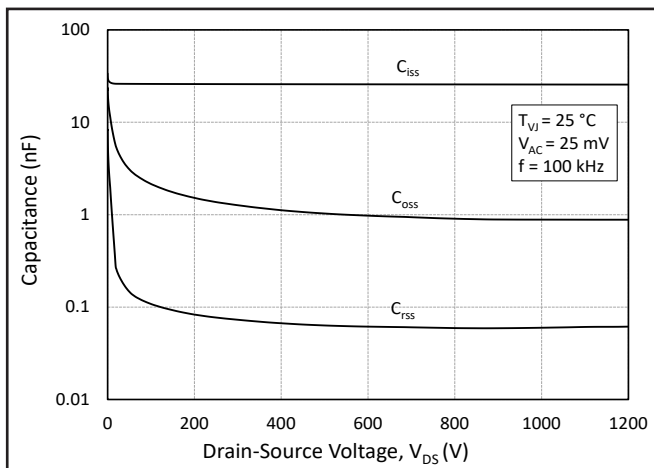
## Typical Performance



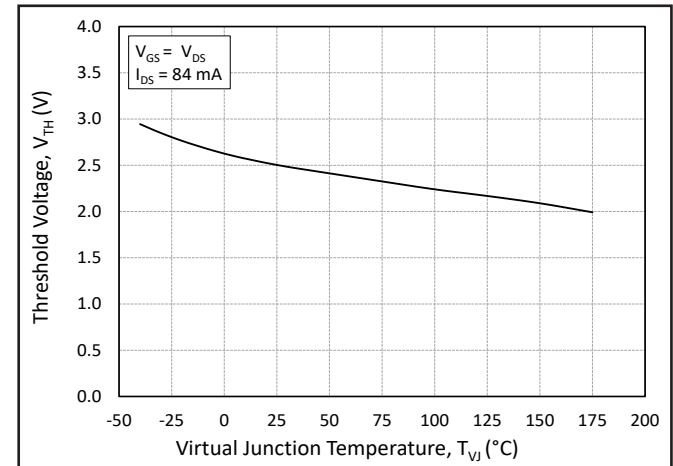
**Figure 7.** 3<sup>rd</sup> Quadrant Characteristic vs. Junction Temperatures at  $V_{GS} = -4$  V (Body Diode)



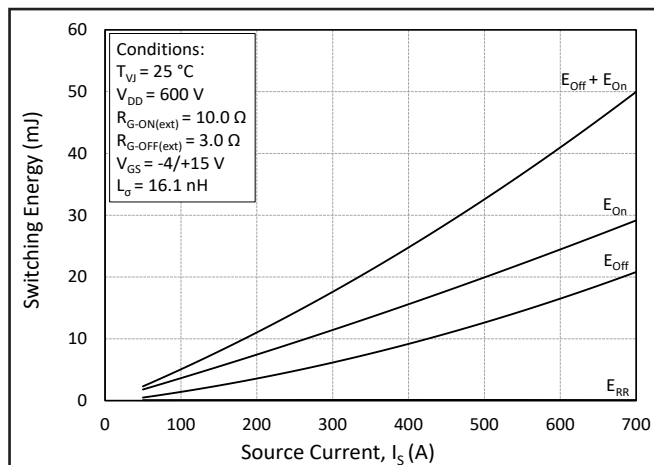
**Figure 8.** Typical Capacitances vs. Drain to Source Voltage (0 - 200V)



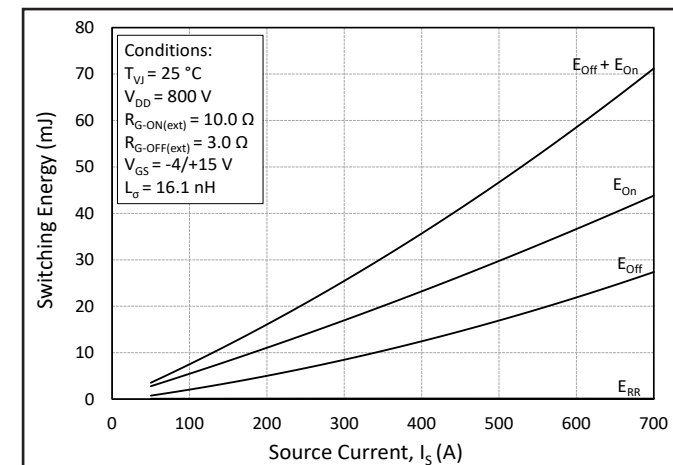
**Figure 9.** Typical Capacitances vs. Drain to Source Voltage (0 - 1200V)



**Figure 10.** Threshold Voltage vs. Junction Temperature

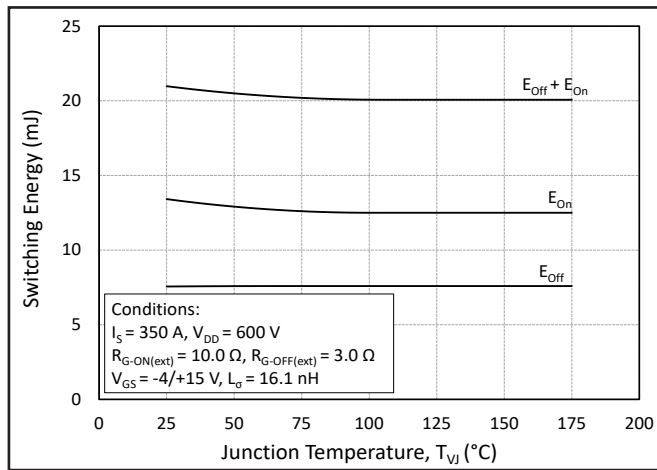


**Figure 11.** Switching Energy vs. Drain Current ( $V_{DS} = 600$  V)

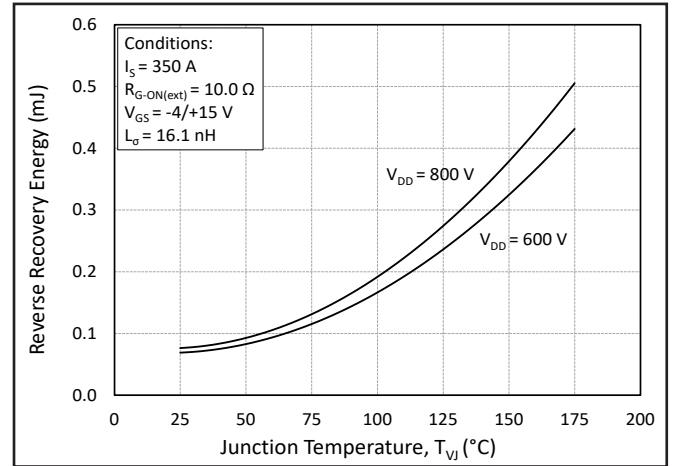


**Figure 12.** Switching Energy vs. Drain Current ( $V_{DS} = 800$  V)

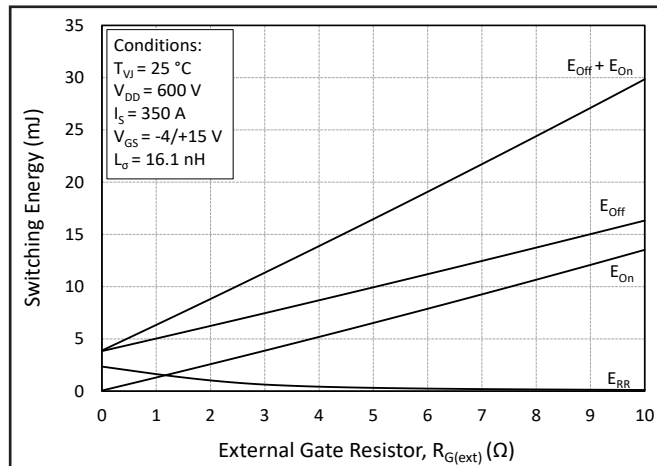
## Typical Performance



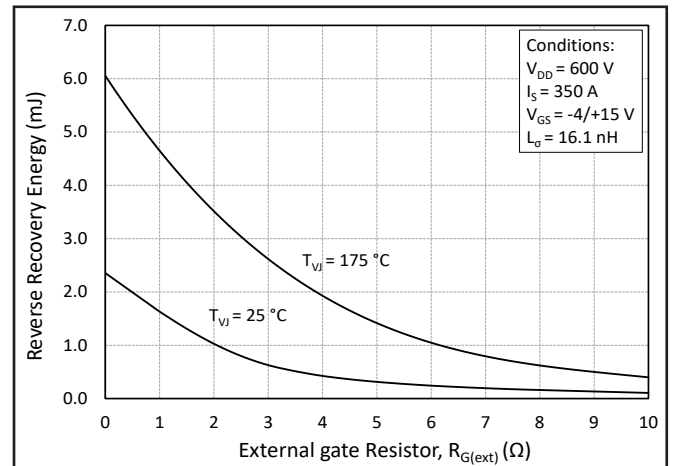
**Figure 13.** MOSFET Switching Energy vs. Junction Temperature



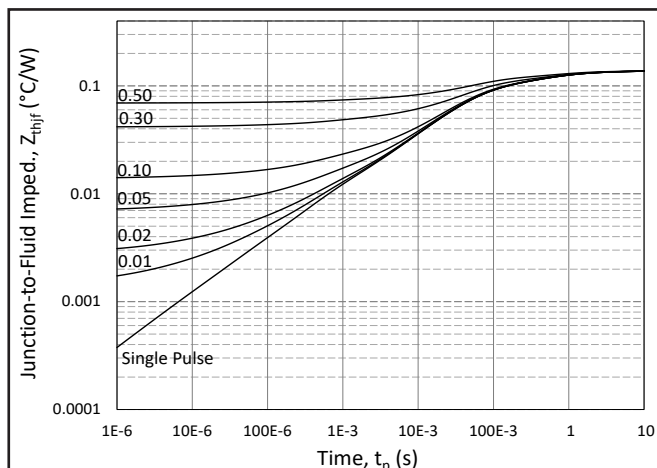
**Figure 14.** Reverse Recovery Energy vs. Junction Temperature



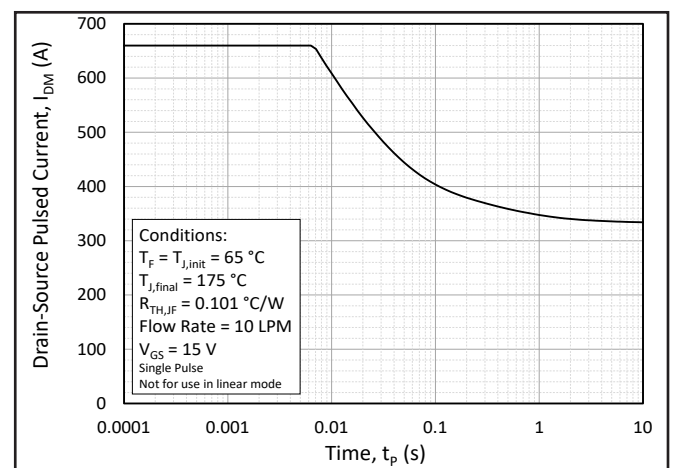
**Figure 15.** MOSFET Switching Energy vs. External Gate Resistance



**Figure 16.** Reverse Recovery Energy vs. External Gate Resistance

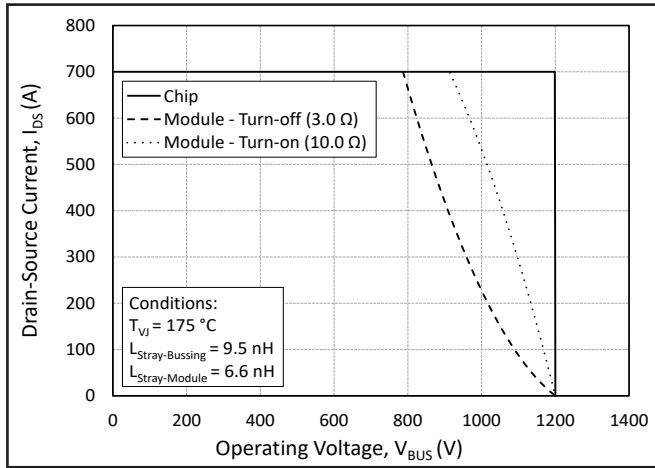


**Figure 17.** MOSFET Junction to Fluid Transient Thermal Impedance,  $Z_{thJF}$  (°C/W)

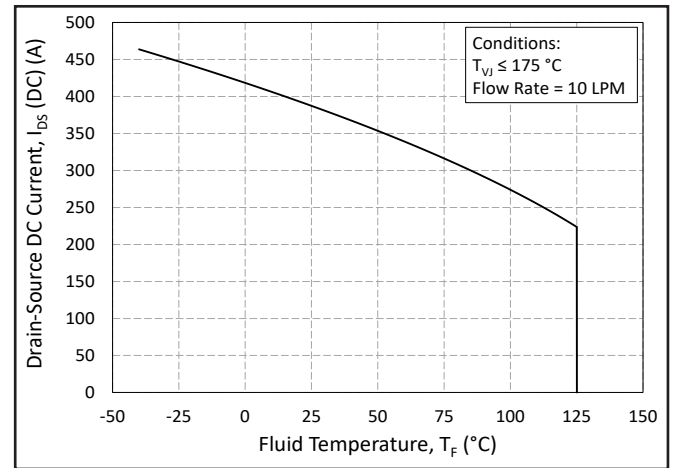


**Figure 18.** Pulsed Current Safe Operating Area (SOA)

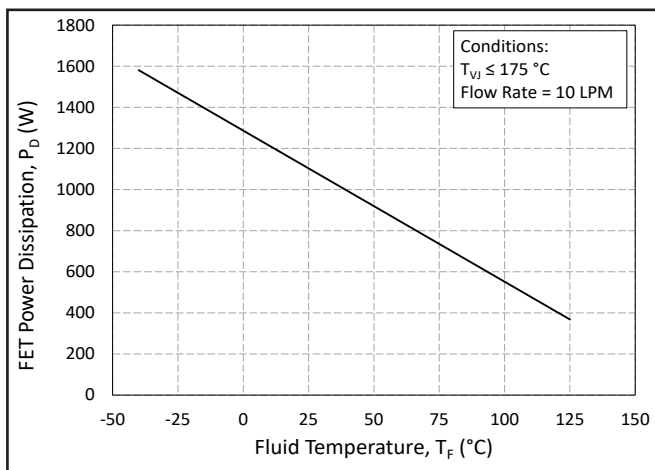
## Typical Performance



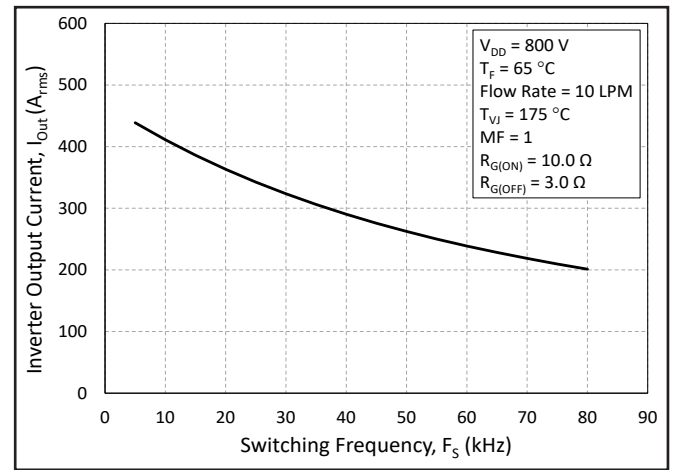
**Figure 19.** Switching Safe Operating Area



**Figure 20.** Continuous Drain Current Derating vs. Fluid Temperature

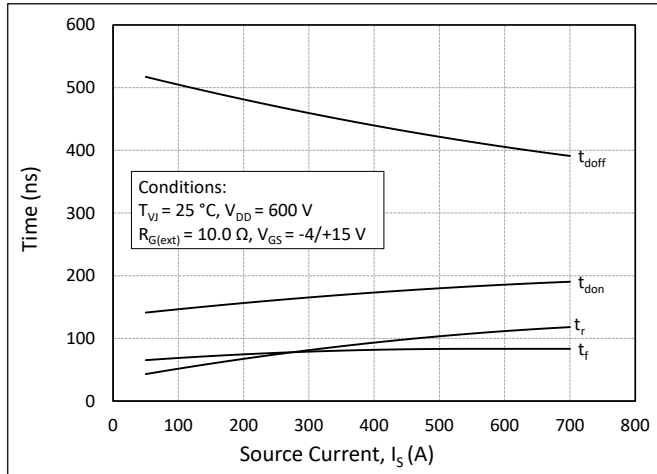


**Figure 21.** Maximum Power Dissipation Derating vs. Fluid Temperature

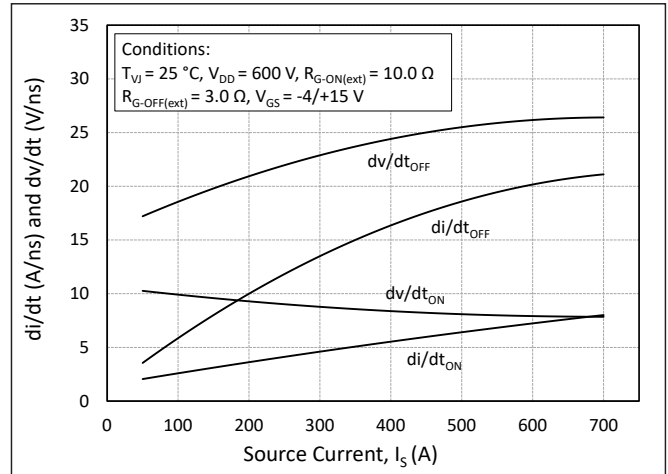


**Figure 22.** Typical Output Current Capability vs. Switching Frequency (Inverter Application)

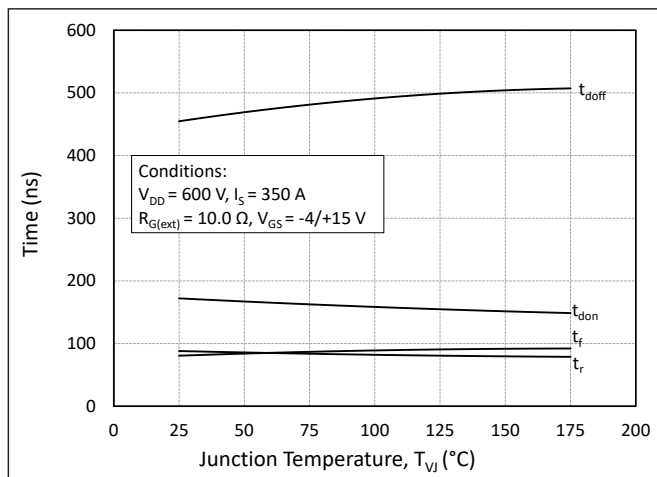
## Timing Characteristics



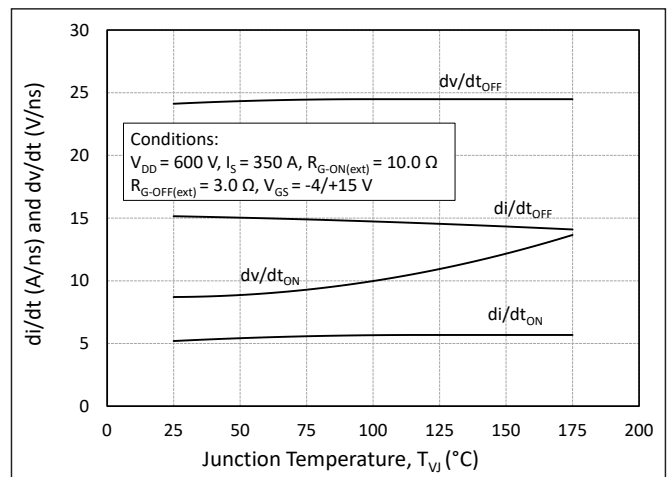
**Figure 23.** Timing vs. Source Current



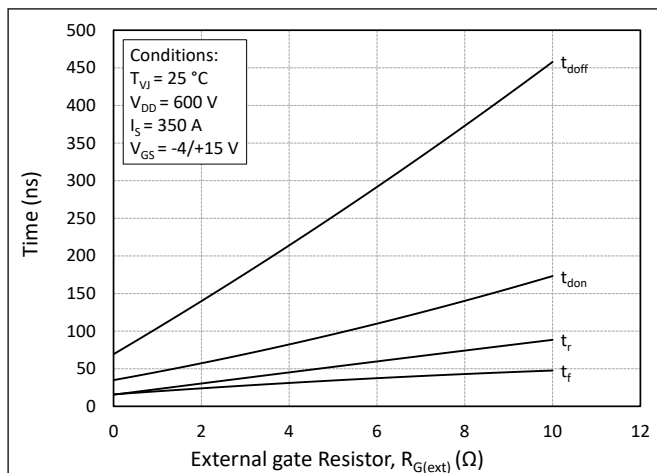
**Figure 24.**  $dv/dt$  and  $di/dt$  vs. Source Current



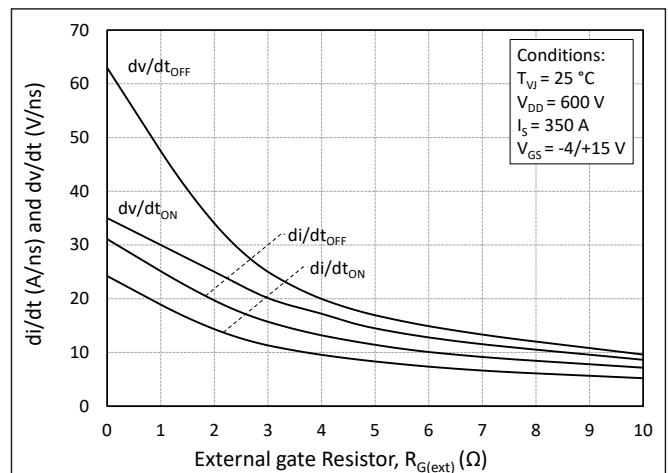
**Figure 25.** Timing vs. Junction Temperature



**Figure 26.**  $dv/dt$  and  $di/dt$  vs. Junction Temperature



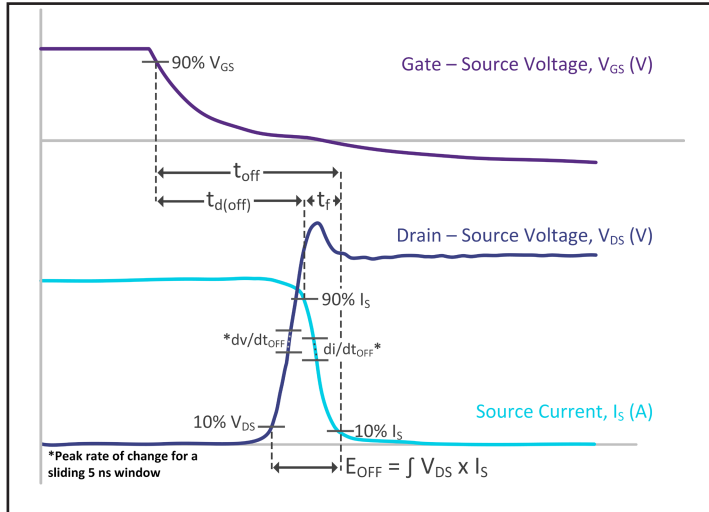
**Figure 27.** Timing vs. External Gate Resistance



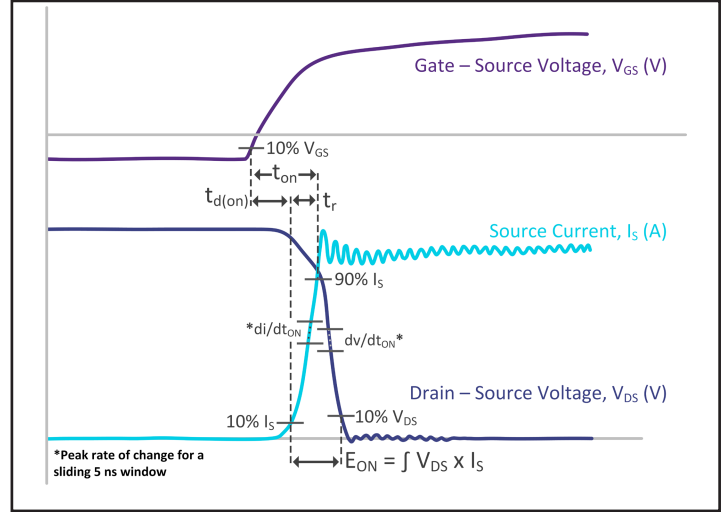
**Figure 28.**  $dv/dt$  and  $di/dt$  vs. External Gate Resistance



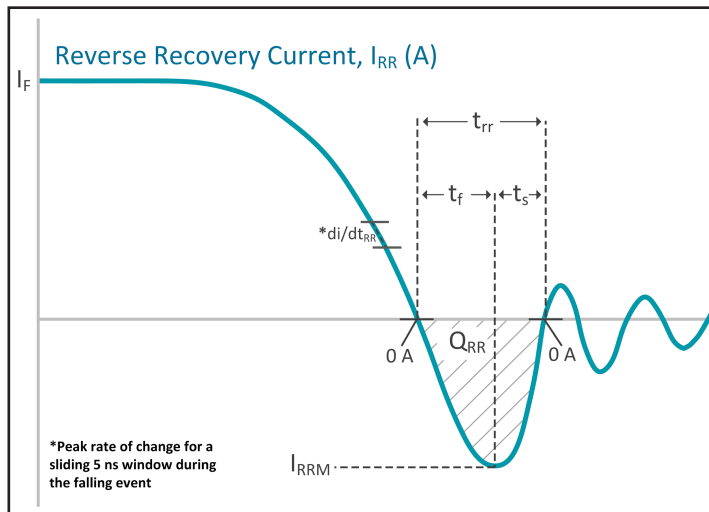
## Definitions



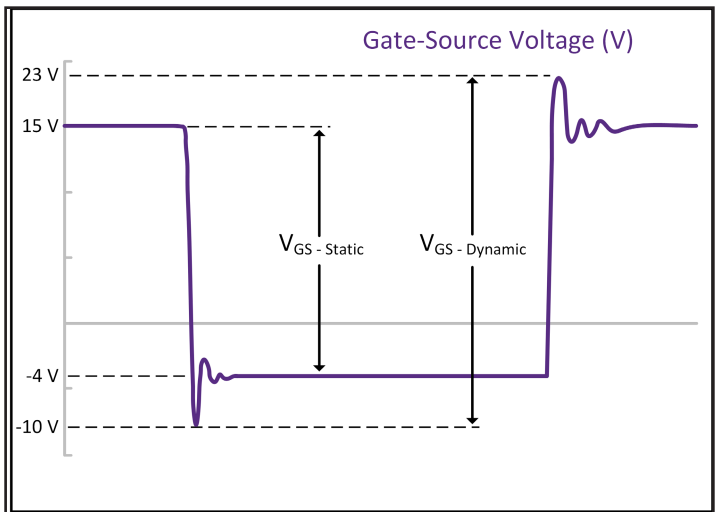
**Figure 29.** Turn-off Transient Definitions



**Figure 30.** Turn-on Transient Definitions



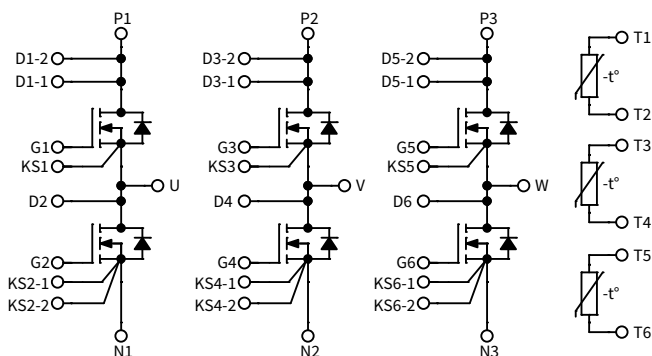
**Figure 31.** Reverse Recovery Definitions



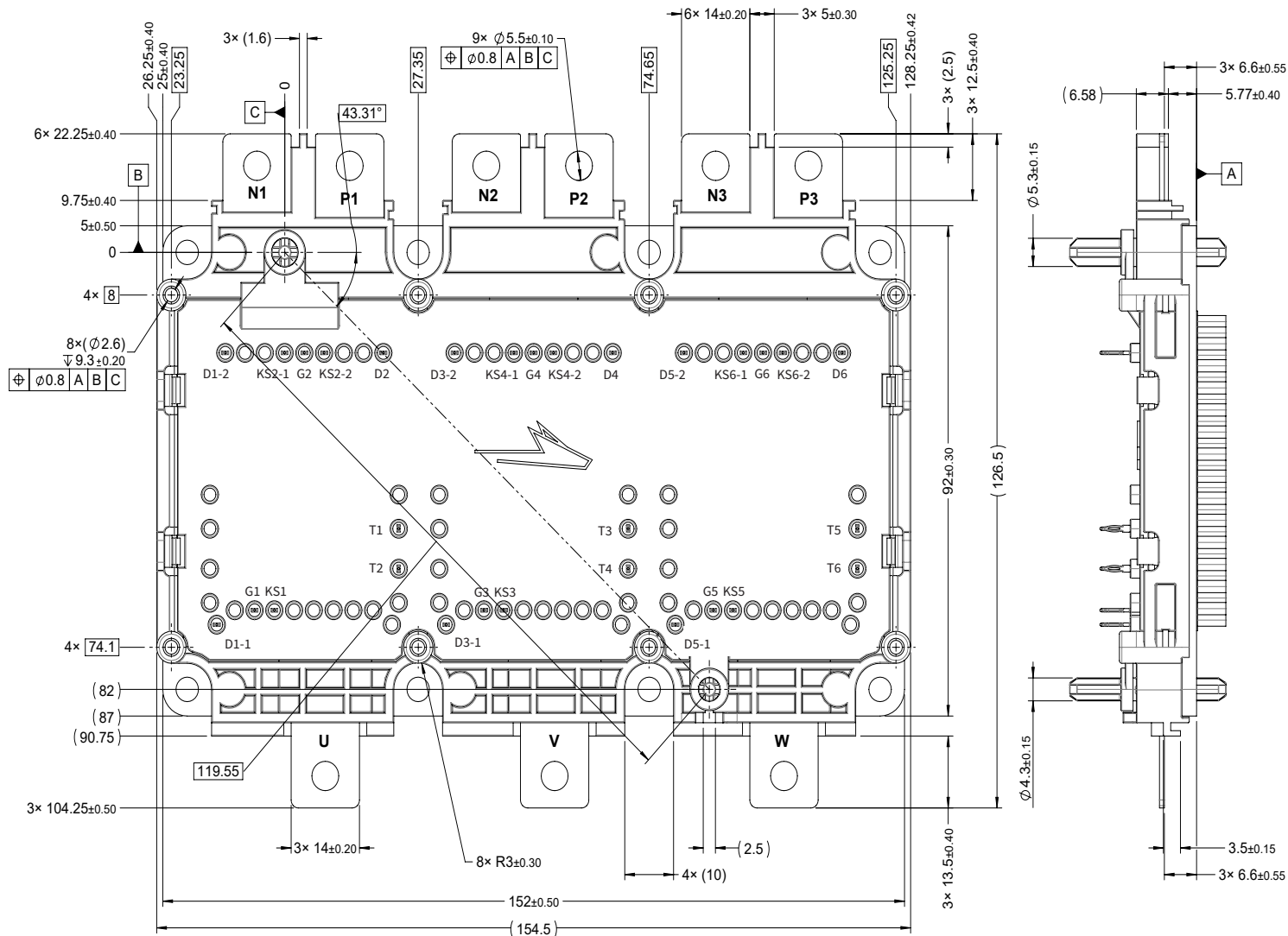
**Figure 32.**  $V_{GS}$  Transient Definitions

Note (6): A gate driver featuring the IXDD614SI gate driver IC was used to evaluate dynamic performance. The typical driver high-state output resistance of  $0.4 \Omega$  and low-state output resistance of  $0.3 \Omega$  are not included in the  $R_{G(ext)}$  values on this datasheet.

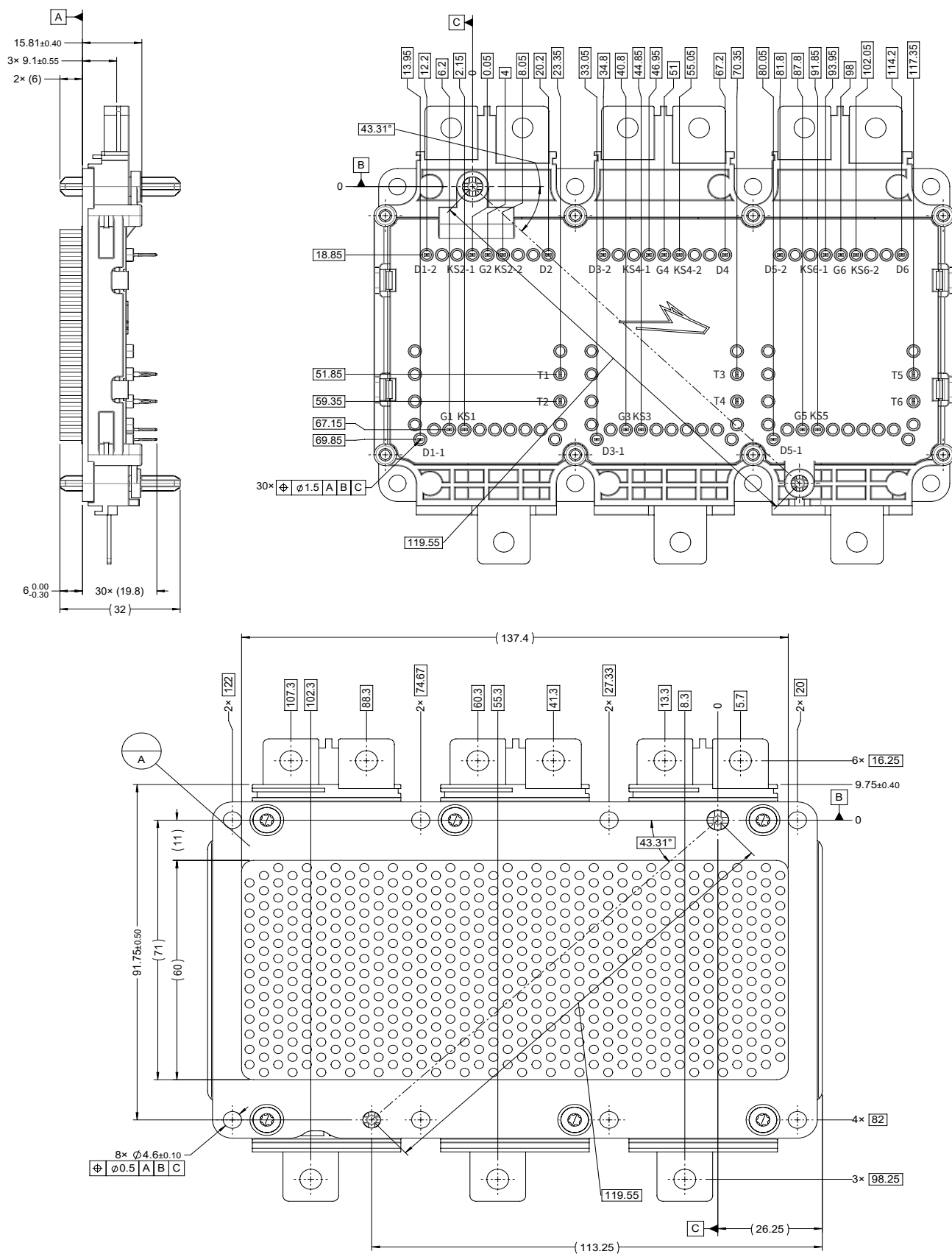
## Schematic and Pin Out



### Package Dimension (mm)



### Package Dimension (mm)





## Supporting Links & Tools

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### Evaluation Tools & Support

- [SpeedFit 2.0 Design Simulator™](#)
- [Technical Support Forum](#)
- [LTspice and PLECS Models](#)

### Dual-Channel Gate Driver Board

- [CGD12HB00D: Differential Transceiver Daughter Board Companion Tool for Differential Gate Drivers](#)
- [CGD1700HB2M-UNA: Wolfspeed Gate Driver Board](#)
- [EVAL-ADUM4146WHB1Z: Analog Devices® Gate Driver Board](#)
- [UCC21710QDWEVM-054: Texas Instruments® Gate Driver Board](#)
- [NXP EV Traction Inverter Control Reference Design Gen 3](#)

### Application Notes

- [PRD-04814: Design Options for Wolfspeed® Silicon Carbide MOSFET Gate Bias Power Supplies](#)
- [PRD-06379: Environmental Considerations for Power Electronics Systems](#)
- [PRD-08333: Wolfspeed Module CIL Evaluation Kits User Guide](#)
- [PRD-08376: Thermal Characterization Methods and Applications](#)
- [PRD-07845: Power Module Baseplate Capacitance and Electromagnetic Compatibility](#)
- [PRD-08710: Measuring Stray Inductance in Power Electronics Systems](#)
- [PRD-08911: Considerations for Current Balancing in Paralleled SiC Power Modules](#)
- [PRD-09035: Power Module RC Thermal Models User Guide](#)



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REACH substances of high concern (SVHCs) information is available for this product. Since the European Chemical Agency (ECHA) has published notice of their intent to frequently revise the SVHC listing for the foreseeable future, please contact your Wolfspeed representative to ensure you get the most up-to-date REACH SVHC Declaration. REACH banned substance information (REACH Article 67) is also available upon request.

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